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SCIENCE DIRECT
International Journal of Psychophysiology 57 (2005) 69 – 77
INTERNATIONAL JOURNAL OF PSYCHOPHYSIOLOGY
www.elsevier.com/locate/ijpsycho

Neural responses of OCD patients towards disorder-relevant, generally disgust-inducing and fear-inducing pictures

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Received 21 October 2004; received in revised form 16 December 2004; accepted 22 December 2004
Available online 22 April 2005

Abstract

This functional magnetic resonance imaging study investigated the disgust- and fear-reactivity of patients suffering from obsessive-compulsive disorder (OCD). Ten OCD patients were scanned while viewing blocks of pictures showing OCD triggers from their personal environment and OCD-irrelevant disgust-inducing, fear-inducing and neutral scenes. Afterwards, the patients rated the intensity of the induced disgust, fear and OCD symptoms. The responses were compared with those of 10 healthy control subjects.

The disorder-relevant pictures provoked intense OCD symptoms in the clinical group associated with increased activation in the bilateral prefrontal cortex, the left insula, the right supramarginal gyrus, the left caudate nucleus and the right thalamus. The patients gave higher disgust and fear ratings than the controls for all aversive picture categories. Neural responses towards the disorder-irrelevant disgusting and fear-inducing material included more pronounced insula activation in patients than controls.

Summarizing, photos of individual OCD-triggers are an effective means of symptom provocation and activation of the fronto-striato-thalamo-parietal network. The increased insular reactivity of OCD patients during all aversive picture conditions might mirror their susceptibility to experience negative somatic states.

Keywords: OCD; Disgust; Fear; Symptom provocation; Visual stimuli; fMRI

1. Introduction

Obsessive-compulsive disorder (OCD) is characterized by recurrent and intrusive thoughts, images or impulses (obsessions), which most commonly revolve around the concern of harming another person or one's own self. The obsessions often trigger repetitive behaviors (compulsions) such as washing, checking or mental rituals (American Psychiatric Association, 1994). OCD is considered an anxiety disorder since obsessions as well as the interruption of compulsions trigger fear. However, some patients report that they are just as bothered by feelings of shame, distress or disgust. Especially for the emotion disgust there are several lines of evidence pointing to its significance for the pathogenesis and maintenance of OCD (e.g. Phillips et al., 1998a).

First, questionnaire studies have revealed positive correlations between subjects' disgust sensitivity and their tendency for obsessive-compulsive behaviors (e.g. Mancini et al., 2001; Schienle et al., 2003a; Thorpe et al., 2003). Furthermore, OCD patients, especially those with contamination fears and washing compulsions, report to experience intense disgust feelings during symptom provocation (Phillips et al., 2000; Sieg and Scholz, 2001).

Finally, it has been put forward that the relevance of disgust for OCD can be derived from brain imaging studies (Phillips et al., 2000). Here, the confrontation with disorder-relevant stimuli triggered activation of the anterior insula, a brain region that has been suggested to be exclusively involved in disgust processing (for a review, see Calder et al., 2001). Via functional magnetic resonance imaging (fMRI), Breiter et al. (1996) examined patients mainly

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doi:10.1016/j.ijpsycho.2004.12.013

suffering from contamination fears and sexual obsessions. In a so-called 'off–on paradigm', the subjects' hemodynamic responses were contrasted between two conditions. During the 'off-condition', they were exposed to an innocuous stimulus (e.g. a tissue soaked in tap water), whereas a disorder-relevant stimulus was presented during the 'on-condition' (e.g. a tissue soaked in toilet water). During the exposure, the patients reported to experience OCD symptoms and showed an increased blood oxygenation in the insula. Additional activation occurred in the orbitofrontal cortex (OFC), the anterior cingulate (AC), the caudate nucleus and the amygdala. In another fMRI experiment by Phillips et al. (2000), patients with washing or checking compulsions as well as healthy control subjects were presented with pictures depicting normally disgusting and washer-relevant scenes from the International Affective Picture System (IAPS, Lang et al., 1997). Whereas in the 'washers-group', both picture types led to an activation of the insula, the control subjects and 'checkers-group' only showed an insula engagement during the disgust condition. The activation pattern during symptom provocation in 'washers' also included parietal regions (angular, supramarginal gyri), the OFC and the AC. Finally, Shapira et al. (2003) investigated the hemodynamic responses of contamination-preoccupied patients towards generally disgust-inducing pictures. The clinical group showed a greater involvement of the right insula, parahippocampal and inferior frontal regions than healthy controls.

There are also negative findings with regard to insular activation during symptom provocation in OCD. McGuire et al. (1994) investigated patients with contamination fears via positron emission tomography (PET). The subjects were exposed to contaminants, which were placed in a sealed tube in their hands. Positive correlations between the rated urge to perform handwashing and the blood flow in the OFC, basal ganglia structures (putamen, globus pallidus, caudate nucleus), the thalamus and the cingulate were found. In a further PET study, Rauch et al. (1994) performed an individualized symptom provocation with patients predominantly suffering from contamination obsessions. During the exposure, as compared to the contact with neutral items, the patients reported an increase in OCD symptoms, which was accompanied by brain activation in the OFC, the AC, the caudate nucleus and the thalamus. Recently, Adler et al. (2000) used a comparable design in their fMRI study. The unmedicated OCD patients who suffered from various symptoms (e.g. contamination fears, repeated counting, ordering) were exposed to disorder-relevant stimuli. This prompted activation in bilateral orbitofrontal and temporal brain regions (including the amygdala), the dorsolateral prefrontal cortex (DLPFC), the AC and the visual association cortex.

Summarizing, neuroimaging research points to a dysfunction of basal ganglia structures (caudate nucleus), the AC, the OFC and the thalamus during obsessive-compulsive states. In contrast, reports on activation of the insula, the amygdala, the DLPFC and occipito-parietal regions are inconsistent.

The exact reasons for the discrepant findings are not easy to pinpoint. However, it is interesting to note that the different studies applied a great variety of provocation methods. Within single studies, patients sometimes had to touch, view or imagine OCD-relevant stimuli (Adler et al., 2000; Breiter et al., 1996; Rauch et al., 1994). Most often, the researchers attempted to realize an individualized symptom provocation by selecting stimuli with an assumed association to the specific syndrome (e.g. a dirty towel for a patient with contamination fears). This procedure was successful in provoking OCD symptoms of moderate intensity. However, from clinical experience, it is known that objects from the personal environment of the patients (especially from their homes) are far more relevant for their OCD symptoms than those from, e.g., the therapeutic context. Patients suffering from washing/cleaning compulsions execute their rituals for the most part in front of their own sinks, showers and bathtubs at home, and ritualized checking mostly refers to electrical appliances or locks in the homes of the patients. This aspect is also taken into account in the treatment of OCD. Psychotherapeutic interventions such as exposure and response prevention are considered to be most effective when they are realized in the environment where the OCD symptoms actually occur (Lakatos and Reinecker, 1999).

A further shortcoming of previous neuroimaging research on OCD symptom provocation refers to the aspect that in the majority of studies only two conditions were contrasted with each other: a disorder-specific and an affectively neutral one (Adler et al., 2000; Breiter et al., 1996; Rauch et al., 1994). This is not sufficient for an interpretation of the underlying emotional dysfunctions during symptom provocation. In order to be able to answer the question of whether or not OCD patients are characterized by an elevated fear and/or disgust reactivity, affective conditions with OCD-irrelevant stimuli need to be included into the experimental design.

Up until now, neural correlates of disgust and fear processing have been studied together mainly in investigations focusing on the recognition of facial expressions (e.g. Phillips et al., 1997, 1998b; Sprengelmeyer et al., 1998). The data has been interpreted as indicating that the insula is selectively involved in the decoding of disgust stimuli, whereas fear specifically engages the amygdala (for a review, see Calder et al., 2001).

This conclusion may however be premature since recent fMRI studies with mimic stimuli (Winston et al., 2003) and scenic stimuli (Schienle et al., 2002a,b, 2004; Stark et al., 2003) did not replicate these findings. Instead, all of the aforementioned experiments demonstrated activation of the amygdala together with visual association regions during the disgust condition, as well as during other high-intensity emotion conditions such as fear. When insula activation was detected, this was also not emotion-specific (Schienle et al.,